SCIENCE

NEW SERIES
VOL. LXVI, No. 1702

FRIDAY, AUGUST 12, 1927

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

SCIENCE

VOL. LXVI AUGUST 12, 1927 No. 1702

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.

PHYSICAL INDETERMINISM AND VITAL ACTION

SCIENCE and philosophy, but especially science, have found great difficulty in reconciling the apparent indeterminism of many vital manifestations, particularly voluntary action, with the strict determinism of physical science. The traditional problem of freedom, with all its vast implications, is the classical expression of this difficulty. One characteristic aspect of this problem seems peculiarly significant, especially when considered in relation to the present state of discussion on the foundations of physical science. This is the qualified nature of freedom as expressed in external action; there is always a large element of restriction or external determination. No one has claimed that vital indetermination is complete, although Bergson speaks of the living organism as exhibiting a maximum of indetermination.[1] To take a simple illustration: the evidence for levitation is doubtful; even its most accomplished exponent would hesitate to launch himself from the edge of a cliff, however firmly he might be convinced of the freedom and efficacy of his own will. And he would continue to rely daily on the mechanical dependability and physically determined regularity of his own bodily organism. I allude to this inconsistency with no merely satirical intention, but simply in order to define as clearly as possible a crucial aspect of the problem. It is undeniable that the organism is subject to rigid physical determination in a large part of its activities; it seems equally undeniable that it is free in others; the difficulty is to decide where determinism ends and indeterminism begins. Intuition gives an overwhelming impression of freedom in voluntary action. Yet analysis, in tracing down the sources of such action, seems always to reinstate determinism; it shows the will to be motivated; motives have their natural origins; actions not consciously motivated either are habitual and referable to past motivation, or are instinctive and determined by heredity. In either case we seem to have a mechanistic determination. Physiology finds in the organism a nexus of physico-chemical determination differing from that in non-living nature only in its complexity; in fact the organism can be shown to depend for its survival on the constancy and stability of its proc-

[1] "Creative Evolution," English translation, Chapter 2; cf. e.g., p. 126.

esses, *i.e.*, on their strict physical determination. Although voluntary action effects mechanical change and seems free, the "energy balance-sheet" of a man shows no conflict with the law of conservation, indicating that there is no creation of energy within the organism. It might be held that the will can direct energy even if unable to create it; but since by Newton's first law force is required to change the direction of a motion as well as to initiate it, we must conclude that a system unable to create energy would be equally unable to direct it arbitrarily. Classical physics thus seems definitely incompatible with the idea of freedom; accordingly scientific men—and somewhat curiously biologists in larger proportion than physicists—have commonly regarded freedom as a delusion. In so doing they may have created more difficulties than they have resolved; certainly the inner conviction of freedom has not been abolished in the minds of most thinking men. But if we accept freedom as a fact, we are bound to consider whether at least a certain measure of physical indeterminism may not also be a fact. Such a residue of indeterminism, if it could be shown to exist, would conceivably explain the indeterminism or inner freedom seen in voluntary action; the evidence for its existence thus becomes a matter of great biological and philosophical interest.

When we inquire into the special physical peculiarities of living as distinguished from non-living systems we are struck by the fact that in the former the determining and controlling events are invariably on an extremely small scale.[1a] The microscope is the chief instrument of biological investigation. In this respect biological phenomena are at the opposite pole from astronomical phenomena. In the latter the possibility of exact prediction attains its maximum; in vital phenomena, on the other hand, prediction is possible only within certain limits; variability seems inherent; indeed in the highest manifestations of life prediction is not possible at all. It is especially such manifestations that we call "free." Such considerations suggest the question: do events cease to be predictable and become free when their spatio-temporal scale becomes sufficiently small? At least we must regard it not as a coincidence but as highly significant that the only region where physical science gives evidence of experimental indetermination, *i.e.*, of externally uncontrolled or individual action, is in the field of ultramicroscopic phenomena. At present quantum phenomena are the subject of debate as to the universality of the rule of unequivocal physical determination.[2] Even on the relatively large scale of Brownian movement any single configuration of a group of particles is as possible as any other, although the different configurations differ in probability. In other words, a given special configuration or grouping is determined by conditions of probability rather than by definitely assignable physical causation. It is well known that Maxwell and Boltzmann have ascribed a purely statistical significance to the second law of thermodynamics; and Svedberg's observations on Brownian movement, confirming the theoretical deductions of Einstein and Smoluchowski, have shown experimentally that within a sufficiently small space and time the second law does not necessarily hold.[3] It follows that the regularity of macroscopic phenomena, in which determinism is for all practical purposes complete and trustworthy, is in reality a statistical regularity.[4] We are not justified in ascribing a similar regularity to single events in the ultramicroscopic field. To a given macroscopic arrangement or condition any one of an infinite number of detailed microscopic configurations may correspond. Our microscopic picture of the world is not complete, but it already seems clear that many of the physical laws with which we are familiar in the realm of macroscopic phenomena cease to apply on the scale where events are determined by quantum relations or by the "chance" fluctuations of molecular movement. Ultramicroscopic phenomena thus give evidence of an ultimate indetermination (defining determination in the usual physical sense of quantitative specification of conditions), *i.e.*, of control by individual action rather than by statistical or mass action.[5] The laws relating to such action—assuming such laws to exist—are as yet imperfectly known, but they are certainly entirely different from physical laws as hitherto understood.

Direct evidence of physical indetermination or freedom is thus to be sought primarily in the behavior of individual particles in the ultramicroscopic field; derivatively, however, we may expect to find it in processes of a larger scale, *provided* these processes are in some way controlled by the ultramicroscopic events. Now vital processes appear to be processes

[1a] *I.e.*, small relatively to the scale of human sense-perception and adjustment.

[2] *Cf.* P. Jordan: "Philosophical Foundations of Quantum Theory," *Nature*, 1927, vol. 119, p. 566.

[3] *Cf.* T. Svedberg: "Colloid Chemistry," New York, 1924, pp. 118 *seq.* "It is obvious that in microscopic systems fluctuations of entropy occur" (p. 120).

[4] See the recent interesting book of Professor C. Guye, "Physico-chemical Evolution," New York, 1[illegible]

[5] *Cf.* F. G. Donnan: "Concerning the Application of Thermodynamics to the Phenomena of Life," *Journ. Gen. Physiology*, 1926, Vol. 8, p. 685: also *Science*, 1918, vol. 24 (2), p. 281.

of just this kind. Living systems are peculiar among the systems of nature in that their characteristic behavior is determined primarily by internal activities of a microscopic or ultramicroscopic kind; as a rule it is only secondarily, as a result of the characteristic "irritability" of living matter, that events in the external world affect the vital processes. This peculiarity is an incident of the special type of physico-chemical constitution characteristic of living protoplasm. Without attempting to characterize the protoplasmic system completely, I would here call particular attention to certain features which are especially relevant to the present discussion. Both the structure and the activity of the system are expressions of its specific chemical activity or metabolism, *i.e.*, of the continual chemical interaction of its component molecules; the synthetic production of new and complex compounds is an especially characteristic feature. This complexity (*e.g.*, of proteins) is itself important, because it implies large molecular weights; and the element of indetermination, in the above-defined sense, is greater (for a given mass of material) when the molecules are large than when they are small, since they are then fewer in number and there is less chance (in the statistical sense) of an individual action being rendered ineffective as a consequence of the law of large numbers. Individual molecular action may thus become an important factor in the determination of processes in the system.[6] This, put briefly, appears to be the essential difference between a living organism, considered as a purely physico-chemical system, and a machine of the usual macroscopic construction.

With regard to the general nature of the conditions determining the special activities of the two types of system, the essential contrast is that between an inner or ultramicroscopic determination of action and an external or mechanistic determination. The ultimate living units (biophores, genes or other physiological units) are characteristically minute, of dimensions corresponding to those in which the range of Brownian movement may be of decisive importance for the momentary behavior of the system. It is thus conceivable that under certain circumstances a single localized extreme oscillation, determined by conditions that can only be described as individual, may form the occasion of a change, *i.e.*, may initiate a process, which will determine the activity of the whole system. How is it possible that an event on such a minute scale can affect the total activity of a system of microscopic or even of macroscopic dimensions, such as a cell or a larger organism? Are not the chances that its effect will be internally compensated by similar oppositely directed effects the same as in any non-living system? To understand the conditions we must recall what is implied in the general property of *irritability*, universally characteristic of living matter. The response to any stimulus implies the transmission of an activating influence from the localized site of stimulation throughout the larger functional area concerned in the response. In other words, the protoplasmic system is characterized by a highly developed power of transmission. Its irritability is inseparable from such transmissivity, and it is this latter property that renders possible the kind of centralized control under consideration. In general, protoplasmic activities are controlled by processes of a spreading kind, which as such necessarily involve amplification. It thus becomes possible for an activity initiated locally in the ultramicroscopic field of the cell or organism to spread to surrounding areas and in so doing to become indefinitely magnified in extent so as to involve the macroscopic field and determine the activities in the latter. Just as the pattern described by the fluctuations of a minute electric current in a telephone system may be reproduced by thermionic amplification in all of its original details but on a vastly larger scale, so the process corresponding to some local activity in the ultramicroscopic field of the living system (*e.g.*, in certain molecules of the nerve cells) may by a spreading action be reproduced—whether in a literal or a representative sense—over a much larger area and express itself in the macroscopic activity of the whole system.

To illustrate the case in a somewhat more concrete manner: a human action, appearing entirely spontaneous and voluntary (free) to both actor and observer, would, if analyzed physiologically, exhibit itself as a succession of mechanistically determined events in all of its macroscopically observable details. Its special *quale* would, if traced down into the finest possible detail, finally appear as dependent upon certain ultramicroscopic events in the nerve cells. What should especially be noted is that when these events were finally reached in the analysis no further definite physical determination could be assigned. The events might in fact not be physically determined—in the sense in which classical physics defines determination—but be examples of indeterminism, *i.e.*, of "free" or externally uncontrolled individual action. Regarding the conditions of such action science has little to say at present. The difference between mechanist and vitalist would then narrow down to the question of how far the *initiatory* process was physically determined or "free." No one would dispute that the macroscopic processes were unequivocally determined or mechanistic; but the inner determina-

[6] *Cf.* the calculation in Donnan's recent paper, *loc. cit.* (1926).

tion in the ultramicroscopic field might quite properly be called free. The question of what physical meaning could be assigned to the term freedom would then arise. Briefly, an internal or individual rather than an external determination would seem to be the essential character implied.

The distinction we are emphasizing is essentially that between the conditions determining macroscopic processes, which according to Maxwell and Boltzmann are determined statistically, and those determining single ultramicroscopic events where individual determination prevails. A smoothing-off or obliteration of inner detail is inevitable in effects controlled by mass action, which as observed represent the sum or integration of numerous fluctuating minutiæ. The relation between a smoothed curve and the distribution of the points showing the individual data is a relation of a similar kind. The inner processes which acting as an assemblage or collectively produce a certain mechanical or other effect might, individually considered, be free. Compare the analogous case of the curves representing the frequency distributions of human voluntary acts like suicide; predictions made on the basis of such curves are reliable if the number of individual cases is sufficient, and the behavior of such a population might seem mechanically determined.[6a] For an essentially similar reason physical determination in the macroscopic realm appears unequivocal and freedom entirely absent. If, however, we consider a system in which single individually determined or "free" ultramicroscopic events—whether Brownian movements, quantum phenomena or something still more ultimate—are in some way enabled to control effectively the macroscopic events in the system, the latter would also appear (to that degree) to be externally uncontrolled or free.

It seems highly probable that the conditions in living organisms are actually of this type. Evidently an inner control of the kind imagined would be possible only in a system with highly developed transmissive properties. The living organism is, however, just such a system. Experimentally it is easy to show that an event of microscopic extent and duration, *e.g.*, a properly localized electric shock or a pinprick, may determine the activity of the whole system. Consider also the relation between the retinal processes and the activities which they control. Such large physiological effects depend, as just indicated, upon the peculiar type of transmission characteristic of living matter—spreading of chemical influence associated with amplification. The degree of the spreading and of the resulting amplification (which may be intensive as well as extensive) is limited only by the distribution of the tracts or surfaces over which the spreading can take place and by the nature of the physiological mechanisms which are thus activated. In higher animals and man these transmitting tracts are represented mainly by the minute and extensive ramifications of the nervous system, which control muscular and other action. In the single nervous element or cell the transmissive process appears to consist essentially in a chemical and structural alteration of the interfacial films at the protoplasmic phase-boundaries. Transmission of chemical influence to a distance by means of the local electrical effects resulting from the alteration of interfacial films is well known in inorganic chemistry—the case of passive iron and similar systems—and shows many close analogies with protoplasmic transmission.[7] Incidentally it may be pointed out, as a special condition favoring indetermination (independence of mass action) in systems having this type of transmission that these films may be monomolecular in thickness; the local ultramicroscopic surface-area where the activity is initiated thus contains fewer molecules than would be the case if the molecules were distributed in three dimensions, and the chance that a single large fluctuation may become effective is correspondingly increased.

It is important to note that the transmissive process itself (*e.g.*, nerve impulse), being on a relatively large scale, belongs in the class of phenomena dealt with by classical physical chemistry. Hence it is limited in its possible range of variation by thermodynamic conditions of the usual kind; correspondingly it is unequivocally regular or determined in its physical character. It is clear that the chain of processes intervening between the physically undetermined initiatory event and the large-scale organic activities must themselves be rigidly determined in character and interconnection, otherwise any precise or regular control would not be possible. In fact, voluntary control is precise to a remarkable degree—as all acts of skill testify—limited only by the physical capabilities of the organism.

An example from the inorganic field, showing how large external effects may be without assignable external causes, may illustrate perhaps more clearly the general nature of the conditions. Every now and then an unexplained explosion occurs in stores of high explosives. We know from observation of Brownian movement, as well as from theoretical con-

[6a] *I.e.*, to an observer whose scale of perception did not permit discrimination of inner detail.

[7] *Cf.* my recent volume, "Protoplasmic Action and Nervous Action," University of Chicago Press, 1923, for an account of this type of transmission.

siderations of probability, that at infrequent intervals an internal molecular or particulate movement of unusual amplitude occurs. Such a movement may exceed the critical minimum below which no chemical reaction results; but if such a reaction should take place locally the whole mass would be ignited by transmission of the explosive type. Explosions due to purely spontaneous activity are thus to be expected in large masses of explosive at intervals; such intervals may be calculable, and the matter might well be tested experimentally, using known volumes of mechanically sensitive explosive kept at appropriate temperatures. A local mechanical shock will set off such a mass, and conceivably an internal particulate movement of large amplitude might have the same effect.[8] The spontaneous activation which occurs in passive iron wires kept in dilute nitric acid —with a frequency increasing with dilution, size of wire and temperature—is an example of a similar condition, also suitable for statistical investigation.

In the living organism the microscopically visible structure shows a definite correspondence with the requirements of the present view. In broad outline we seem to perceive the character of the nexus through which submicroscopic events are enabled to control microscopic and ultimately macroscopic events. It is clear from general considerations that a heterogeneous system such as protoplasm is favorable to a centralized type of control of the kind indicated.[9] Experimental studies lead to a similar conclusion. Modern genetics indicates that submicroscopic particles (genes) determine the special details of inheritance;[10] in an analogous manner minute local stimuli determine the activation of extensive physiological mechanisms, and minute areas of active growth determine the form adopted by the growing embryo. Just as submicroscopic events thus determine microscopic events, so behind or internal to the submicroscopic events we must assume a series of ultramicroscopic events reaching back by convergence into the field where the known types of physical determination are replaced by another type of determination, the special conditions of which we do not know. Apparently, however, this type contains possibilities of a kind entirely different from those with which we are familiar from our experience of large-scale phenomena. In this field events occur which appear to be free, *i.e.*, internally rather than externally determined, although we can as yet give no scientific account of the conditions of such determination.

We may now briefly consider the question: how are we to conceive the conditions of action in the remote ultramicroscopic field where physical determination, as hitherto understood, seems to fail? This field, beyond the range of the classical or deterministic physics, is now, thanks to the methods of the new physics, open (in part) to experimental investigation. One may therefore hesitate to call it the ultraphysical field—still less the metaphysical. Probably it can be characterized satisfactorily only on the basis of future research. It would seem, however, that there must be some final support or substratum of the physical to which only the term metaphysical can be applied. The question becomes: is action in this field free? and if so what is meant or implied by the term? Two possibilities suggest themselves. If by free we mean externally uncontrolled, it would appear that the ultimate local centers or units of action should be independent of one another: *i.e.*, a radical discontinuity should exist at the basis of physical reality. Something of the kind seems to be indicated by quantum phenomena. There is also the general philosophical position that the universe, considered in its totality, must be the expression of free action, since an all-inclusive whole can not be determined externally, *i.e.*, by conditions outside itself. How otherwise are we to account for its having the special and arbitrary character which it actually does have, instead of any other one of the infinity of possible alternative characters? Claude Bernard, indeed, while working actively in experimental physiology, referred the ultimate vital determination to the metaphysical world. In this world, he considered, freedom was possible, although in experimental biology he insisted on a rigid determinism.[11] What is significant is that in both of the possibilities just considered an ultimate determination other than physical is implied, but without infringing the usual types of physical determination.

It may be objected that (*e.g.*) intra-atomic phenomena are not undetermined, but are determined according to laws which are still physical laws, however different they may be from those prevailing in the macroscopic or mechanical sphere. The stability

[8] For a discussion of the chances of appreciable mechanical effects resulting from Brownian movement, *cf.* a recent book of Professor G. N. Lewis, "Anatomy of Science," Yale University Press, 1926, p. 145. Incidentally the case of levitation comes in for consideration.

[9] *Cf.* the discussion in Guye's "Physico-chemical Evolution," p. 136.

[10] Freundlich has considered the possibility that fluctuations in the Brownian movement of the genes may be at the basis of mutations: *Naturwissenschaften*, 1919, Vol. 7, p. 832.

[11] *Cf.* the recent English translation of Bernard's book on "Experimental Medicine," Macmillan Co., New York, 1927.

of an atomic system in itself implies strict determinism. Our amended conclusion therefore would be that events are determined, in the sense of being subject to law, in the ultra-mechanical as well as the mechanical world, but that the conditions of this determination are fundamentally different. The term "physical indeterminism" might by some be regarded as a misnomer. We seem, however, to have reached a stage in scientific development where physical terms are acquiring unexpected meanings; the present contention would simply be that the older physical conceptions of determinism may not prove applicable to the new range of phenomena, and that the experimental facts themselves may oblige us to admit the existence of determining factors indistinguishable in essence from those which formerly we called free. This, however, is not a philosophical but a scientific paper; and my present aim is simply to indicate an objectively valid source of determination for certain fundamental vital phenomena which hitherto have proved refractory to analysis.

Ralph S. Lillie

Marine Biological Laboratory,
June, 1927

HENRY PAUL TALBOT

The death of Dean Henry Paul Talbot deprives the institute of the services of one of its most cherished alumni, one who devoted his life in a noteworthily unselfish way to the upbuilding of his Alma Mater. For forty years he gave the best of his brain and heart to the development of teaching and administration and to the advancement of the Massachusetts Institute of Technology as a great school of engineering and science.

Dr. Talbot graduated at the institute in 1885 and received the degree of doctor of philosophy from the University of Leipzig in 1890. He returned to the institute as an instructor and was rapidly promoted through the several grades and was finally appointed professor of analytical chemistry in 1898. He showed marked administrative ability and from 1895 was nominally in charge of the department of chemistry, although his official appointment to this post was not made until 1901. He served as chairman of the faculty from 1919 to 1921, as chairman of the administrative committee from 1920 to 1923 and as dean of students from 1921.

Dr. Talbot's training in chemistry was broad: his work as a student equipped him with the point of view of the analytical chemist; his research for his doctorate was in organic chemistry; and he devoted much attention to the study in Germany of the new physical chemistry which was being rapidly developed at that time. He was impressed with the importance of the advance of the science in this direction, and on his return from Germany he introduced at the institute a course in physical chemistry, which he taught successfully. This course was one of the first in this subject given in American universities.

When Dr. Talbot took over the instruction of the first-year students, he felt the advisability of bringing before them the more fundamental concepts of the newer chemistry. He accordingly prepared, with the assistance of Professor Arthur A. Blanchard, a text for this purpose entitled "The Electrolytic Dissociation Theory." Professor Talbot's progressive action in these two cases is typical of his attitude in educational affairs. He was the leader in the development of his department to its present efficient condition and served as chairman of committees on chemical education in the American Chemical Society and the Society for the Promotion of Engineering Education. He showed unusual interest in the teaching of high school science and was helpful in organizations devoted to the improvement of teaching in this field. He served as president of the New England Chemistry Teachers' Association and was for several years chief examiner in chemistry of the College Entrance Examination Board.

Dr. Talbot's record as a member of the American Chemical Society brought to him the honor of election as one of the five directors who determine the most important policies of the society and have full charge of its finances. He has been a member of the council since 1898; he served as associate editor of the *Journal* of the society and as chairman of the division of inorganic and physical chemistry. He also was a member of many important committees.

During the world war Dr. Talbot was appointed a member of a small committee to act in an advisory capacity to the Bureau of Mines in the work it had undertaken in correlating the chemical activities of the country to meet the problems arising from gas warfare. He was particularly helpful in presenting to the Secretary of War directly the needs of this organization, which carried on for over a year, outside of the war department, all the work on war gases.

Dr. Talbot was always interested in research. In the years following his return from Germany he published the results of several investigations in the field of inorganic and analytical chemistry. For a number of years he was chairman of the committee of the American Academy of Arts and Sciences that has charge of the C. M. Warren Fund, the income of which is devoted to aiding chemical research. In recent years the small amount of time available, after he had completed his work as a teacher and administrator, was devoted to editorial work and the writing

of papers on educational, scientific and industrial subjects. He is the author of a widely used text-book on quantitative analysis. Professor Talbot was the consulting editor of the International Chemical Series, which comprises books on a wide range of subjects in the field of chemistry. During the war the *Atlantic Monthly* published a series of papers by him on gas warfare. These were written in the interesting and lucid style which is characteristic of all of his writings. As chairman of the faculty, and of the administrative committee after the death of President Maclaurin, Professor Talbot had much to do with shaping the recent policies of the institute.

Professor Talbot's work has always been appreciated by chemists. Dartmouth College gave him the honorary degree of doctor of science in 1921. In bestowing the distinction his record was summed up as follows: "Henry Paul Talbot—administrator and scholar, faithful and versatile contributor to the welfare of a distinguished sister institution of high learning; scientist whose interest in the discovery of new truths is matched by instinct for the application of those truths, of whose knowledge you have possessed yourself; by virtue of the authority vested in me I welcome you to the fellowship of Dartmouth men and I confer upon you the honorary degree of doctor of science."

In the midst of all his scientific, educational and administrative activities Dr. Talbot consented to accept the important appointment of dean.

Dr. Talbot always showed a keen personal interest in the students as individuals. One of my colleagues, in pointing out the cordial relationship that existed between Professor Talbot and the students who knew him well, noted the fact, evident to us all, that he retained the spirit of youth. To the younger members of the department which Dr. Talbot directed for so many years, his life was always an example of loyal devotion to an ideal; every official act was the result of a conscientious and unselfish desire to do what was best for the Massachusetts Institute of Technology. His will, filed for probate just before this was written, expressed in a concrete way his interest in these younger men and in the institute. He names the institute as a residuary legatee and suggests, but does not require, that a part of the whole of the bequest be used to assist junior members of the institute's staff to attend meetings of the societies of their professions.

JAMES F. NORRIS

SCIENTIFIC EVENTS

TOPOGRAPHIC MAPS OF WESTERN NATIONAL PARKS

Two topographic maps of western national parks have been published by the Geological Survey of the Department of the Interior; one is a map of an area including the Sequoia and General Grant National Parks, California, and the other a map of the east half of the Grand Canyon National Park, Arizona.

The maps are printed in three colors—black showing the works of man, blue showing the rivers and other water features and brown showing the contour lines of altitude that are the distinguishing features of a topographic map. Both maps appear almost like relief models of the areas they portray.

The Grand Canyon map includes the part of the Grand Canyon extending from its head southward and westward to Crystal Rapids and bounded on the north by the Kaibab Plateau, on the east by the Painted Desert, and on the south by the Coconino Plateau. The great contrasts in topography between the canyon slopes and the surrounding plateaus and those between the walls of the main canyon and of the Granite Gorge are clearly shown. The sculptural details of the canyon walls, as well as the buttes and the temples that stand out from the main slopes, are faithfully represented on the map, and the fact that the surface of the Coconino Plateau descends southward away from the canyon rim is well shown along the southern margin of the map. The numerous rapids along the Colorado River are indicated by symbols, and the location of the trails, camps and springs are shown. The Grand Canyon map measures 41 by 65 inches and is sold by the Geological Survey at 25 cents a copy.

The map of the Sequoia and General Grant National Parks embraces an area in eastern California, situated mainly in the Sierra Nevada, and includes these two parks, the Sequoia National Game Reserve, and considerable portions of the Sequoia, Sierra and Inyo National Forests. The northeast corner of the area lies in the Inyo Mountains, and the east side is crossed by Owens Valley, whose floor is shown to lie some 3,700 feet above sea-level. West of Owens Valley the great eastern wall of the Sierra rises abruptly 5,000 to 7,000 feet and is topped by many summits that stand 12,000 to 14,000 feet above the sea. Among them is Mount Whitney, 14,501 feet, the highest point in the United States. The western slopes of the Sierra, which occupy the greater part of the area shown on the map, are seen to be deeply trenched by the rugged canyons of Kings, Keweah and Kern Rivers—the Kings River canyon one of the deepest in the world. This part of the area abounds in gorges, domes, alpine meadows, glacial cirques and cirque lakes, there being several hundred small lakes among the higher summits and divides. The area also contains a dozen groves of the "Big Trees." This map measures 32 by 29 inches and may be obtained from the U. S. Geological Survey, Washington, D. C.

STANDARDS FOR SCIENTIFIC AND ENGINEERING SYMBOLS AND ABBREVIATIONS

THE decision to undertake the standardization of scientific and engineering symbols and abbreviations as a national enterprise was made at a general conference called by the American Engineering Standards Committee and held in the rooms of the American Society of Mechanical Engineers on February 13, 1923. Three organizations, the American Institute of Electrical Engineers, the Association of Edison Illuminating Companies and the American Society of Mechanical Engineers, made the original recommendations which resulted in the calling of this conference. Official representatives of national organizations attended this conference and after a full discussion they voted unanimously that this project should be undertaken, and that the American Association for the Advancement of Science, the National Research Council, the Society for Promotion of Engineering Education and the U. S. Bureau of Standards should be requested to accept joint sponsorship. Later the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society of Civil Engineers were invited to become joint sponsors.

The sectional committee on scientific and engineering symbols and abbreviations now consists of thirty members representing thirty-seven national organizations. It has organized nine subcommittees to which have been assigned the following divisions of the subject, (1) Symbols for Mechanics, Structural Engineering and Testing Materials, (2) Symbols for Hydraulics, (3) Symbols for Heat and Thermodynamics, (4) Symbols for Photometry and Illumination, (5) Aeronautical Symbols, (6) Mathematical Symbols, (7) Electrotechnical Symbols including Radio, (8) Navigational and Topographical Symbols, (9) Abbreviations for Scientific and Engineering Terms. The reports of these subcommittees will be prepared and issued separately.

Mathematical Symbols. The proposed standard for Mathematical Symbols was developed by Subcommittee No. 6, of which Mr. Edward V. Huntington, professor of mechanics, Harvard University, is chairman. A draft of this subcommittee report was considered at a meeting of the executive committee of the sectional committee in January, 1927, and was approved, with slight amendments, which subsequently were introduced into the report by the subcommittee. The report was submitted to the members of the sectional committee on April 25, 1927, and received its approval. A few minor suggestions for modification were submitted by individuals, but it has been considered inexpedient by the sectional committee to reopen the whole matter for consideration of these few individual suggestions.

They are, therefore, included as an "Appendix" to the report, with the recommendation that when the report shall be reconsidered for revision they shall receive due consideration. The proposed standard is now before the five sponsor bodies for their approval and transmission to the American Engineering Standards Committee for approval.

Aeronautical Symbols. Subcommittee No. 5, Professor Joseph S. Ames, the Johns Hopkins University, chairman, has taken advantage of the early work of the National Advisory Committee on Aeronautics. The list of approximately 100 letter symbols which it now proposes for criticism and comment have for the most part been in use by the National Advisory Committee for the past few years.

This report of the subcommittee was approved by the executive committee of the sectional committee, January 22, 1927, subject to possible modification by the executive committee after consideration of conflicts and duplications in symbols. The attached statement of conflicts and duplications in symbols was considered by the subcommittee, after which the original report was reaffirmed on April 19, 1927. The subcommittee report is now issued in tentative form with a request for criticism and suggestion from all concerned. Communications may be directed to Preston S. Miller, secretary of the sectional committee, Eightieth Street and East End Avenue, New York, N. Y.

FLOOD CONTROL BY REFORESTATION IN MISSISSIPPI

AN extensive survey under which will be brought together all available information upon the location and area of forests needed on the Mississippi watershed as a part of flood prevention and control has been started by the Forest Service of the United States Department of Agriculture and will be completed by early fall.

"The survey," says Col. William B. Greeley, chief forester, "will define the main tributaries of the Mississippi to be treated as units, and for each of these tributaries data will be brought together on the acreage, the amount and character of the precipitation, the more essential or more common soil classes, features of physiography, including ruggedness of topography, natural reservoirs, etc., the general character of the vegetative cover, and a rating of the value of the protective cover as a means of flood prevention and control."

The object of the survey is to bring out on the enormous drainage basin the area or watersheds where, on account of rainfall, character of soil, topog

raphy, etc., forest cover has an important protective value.

Considering especially character of soil, steepness of slope, and character of precipitation, a rating will be given the protective value of forest cover as an element of the particular watershed. The plan is to eliminate watersheds where on account of these factors the maximum protective influence that a forest might exert would have a comparatively minor effect upon stream and flood conditions, and to locate the areas where, because of soil, topography and precipitation, the effect of forest cover would be important.

A somewhat similar rating of the protective efficiency of the existing forest cover on the Mississippi system's watersheds is proposed. The plan contemplates putting all this data as far as possible on a set of maps for ready consultation in the formulation of comprehensive plans for flood prevention and control in the Mississippi Valley. The data obtained by the Department of Agriculture through the Forest Service will be correlated with that of the War Department and other agencies for the construction of reservoirs and other engineering methods of flood control.

E. A. Sherman, associate forester, has been named the direct the survey.

THE FIELD MUSEUM OF NATURAL HISTORY

EXTENSIVE engineering changes are being made in Field Museum of Natural History. As a result of this work, fourteen large additional halls will be made available for museum exhibits, and the heating of the new Shedd Aquarium, the stadium in Soldier Field and the museum itself will be centralized in the Field Museum's heating plant. For more than a year past the museum has been supplying heat to the stadium, and an arrangement was recently entered into between authorities of the projected Shedd Aquarium and the museum to supply heat to the new institution.

Of the halls gained for public exhibits in the museum by the changes being made, eleven will be devoted to anthropological collections, and three to zoological subjects. The work is being rushed in the hope of completing it by October 1. Shortly after that date, it is expected, operations for installation of collections in the new halls will begin, and as soon as each hall is arranged with its exhibits it will be thrown open to the public. The entire fourteen new halls probably will not be in use until a considerably later date.

The continued development of Field Museum as an institution of world importance, and the constant flow of accessions of valuable material in all four of its departments—anthropology, botany, geology and zoology—through expeditions sent out by it, and through gifts of its friends, have made more space an absolute necessity.

The halls to be gained are on the ground floor of the building, and will constitute about two thirds of the 245,000 square foot area of this floor. All pipes and other obstructions, which have made this space unavailable for exhibits in the past, are being removed. Steam and water pipes, now running along the ceilings, will be carried through underground trenches and tunnels, increasing the headroom of the halls and bettering their appearance. The pump room on the ground floor will be depressed.

The new halls will enable the museum to have a well-ordered geographical and scientific arrangement of the anthropological collections. Among exhibits planned for these halls are those from Melanesia, the Philippine Islands, Malay Peninsula and Malay Archipelago, Polynesia, Micronesia, Madagascar and East Africa, North, West and South Africa, India, Egypt and Mesopotamia. Their installation in the new halls will make it possible to devote the entire east wing of the main floor exclusively to North, Central and South American archeology and ethnology. One of the new halls will be devoted to exhibits illustrating the progress of prehistoric man, for which Henry Field, assistant curator of physical anthropology, is now collecting in Europe. Another hall will be devoted to physical anthropology.

A special significance is attached to the use the department of zoology will make of the space allotted to it in the new halls, as it will place the lower orders of animals, chiefly denizens of the sea, on this lower floor, while the higher orders of animals will remain on the main floor. A feature of the new halls will be one devoted to large marine mammal habitat groups such as whales, walruses, seals, sea lions, porpoises and so forth. Another hall will hold systematic collections of fishes, and the third will be devoted to marine invertebrates, such as starfish, mollusks and similar creatures.

Removal of these collections from the general zoological collections in the west wing of the main floor will make possible opening there a new hall of Asiatic mammal habitat groups, the nucleus of which will be the collections made by the James Simpson-Roosevelt Asiatic Expedition of the Field Museum, conducted in 1925 under the leadership of Colonel Theodore Roosevelt and Kermit Roosevelt. It is expected that about January 1, 1928, the first two groups will be installed ready for exhibition. These will consist of the famous Ovis Poli sheep, named for the great explorer Marco Polo, and the

ibex, of which the Roosevelts secured a world's record head.

SCIENTIFIC NOTES AND NEWS

EDWARD BRADFORD TITCHENER, Sage professor of psychology at Cornell University, died on August 3, aged sixty years. Dr. Titchener was born in Chichester, England, and was called to Cornell University in 1892.

THE seventieth birthday, occurring on August 8, of Professor Henry Fairfield Osborn, president of the American Museum of Natural History, was celebrated on July 28 by the presentation of a Queen Anne cup made by Thomas Folkingham in 1711, and an illuminated book of resolutions containing the signatures of his colleagues and friends from all the world over. These signatures were made on individual slips of vellum and included nearly a thousand names. The design and decorations of the book were executed by William E. Belanski. The presentation took place in advance of Professor Osborn's birthday owing to the fact that he was obliged to be in the west on August 8. The committee in charge of the celebration have also invited Professor and Mrs. Osborn to be the guests of honor at a reception to be given on September 29, on which occasion the balance of the fund raised by his friends, amounting in all to nearly seven thousand dollars, will be presented to him for his research work.

DR. HENRY S. WASHINGTON, of the Geophysical Laboratory of the Carnegie Institution, has been nominated by the Italian government an officer of the Order of the Crown of Italy and has received from the Italian ambassador, Baron de Martino, the cross of the order in recognition of his work on the rocks and volcanoes of Italy.

DR. F. B. MUMFORD, since 1909 dean of the College of Agriculture and director of the experiment station of the University of Missouri, and his brother, Dr. H. W. Mumford, since 1922 dean and director of the Illinois College of Agriculture, recently received the honorary degree of doctor of agriculture from the Michigan State Agricultural College, where both were graduated thirty-six years ago.

THE University of South Dakota at the recent commencement exercises conferred upon Dr. L. S. Hulburt the honorary degree of doctor of laws. Dr. Hulburt is professor of mathematics, emeritus, in the Johns Hopkins University. Before going to the Johns Hopkins University in 1892 he was for four years professor of mathematics in the University of South Dakota.

MRS. ZELIA NUTTALL has been elected a fellow of the Royal Anthropological Society of Great Britain and Ireland and a corresponding member of the Geographic Society of Philadelphia to fill the vacancy created by the death of Sir John Scott Keltie.

DR. R. RUGGLES GATES, of the University of London, received the doctorate of laws *in absentia*, at the commencement exercises of Mount Allison University, Sackville, N. B.

M. LEONARDO TORRES-QUEVEDO, engineer of bridges and roads of Spain, has been elected foreign associate of the Paris Academy of Sciences to succeed the late H. Kamerlingh Onnes.

THE Hanbury Memorial Medal, which is given for excellence in the prosecution or promotion of original research in the chemistry or natural history of drugs, has been awarded to Dr. T. A. Henry, director of the Wellcome Chemical Research Laboratories.

M. PIERRE SALET, of the Observatory of Paris, has been promoted from adjunct astronomer to astronomer, to succeed M. Bigourdan, who recently retired.

CARLOS G. BATES, recently director of the Rocky Mountain Forest Experiment Station of the Forest Service, has been appointed director of a new section in the Forest Products Laboratory, at Madison, Wis., which will work on biological problems.

DR. JOSEPH JASTROW, since 1888 professor of psychology at the University of Wisconsin, has retired and has been made emeritus professor of psychology.

THOMAS A. EDISON visited the Department of Agriculture in Washington on July 26 to discuss questions of rubber culture. He conferred with Drs. W. A. Taylor, chief, and Karl F. Kellerman, associate chief, of the Bureau of Plant Industry. A representative of the War Department attended this conference. Mr. Edison was accompanied by one of his assistants. He also conferred with officials of the Department of Commerce on the subject of rubber.

W. L. MCATEE, in charge of the division of food habits research of the Bureau of Biological Survey, recently returned from Europe, where he was from the middle of March to the middle of June on official business connected with the work of that bureau and the Bureau of Entomology. He investigated methods of propagation of waterfowl and other game birds, many of them the same species that occur in the United States. This work was carried on at nine establishments in France, Holland and Great Britain.

DR. GEORGE KEMMERER, professor of chemistry in the University of Wisconsin, and Dr. W. H. Rich, of the United States Bureau of Fisheries, are making this summer a scientific study of the water of the lakes on Kodiak Island, Alaska. Professor Kemmerer has

assisted Dr. E. A. Birge, of the University of Wisconsin and the State Geological and Natural History Survey, in the studies he is directing of plant and animal life in Wisconsin lakes, and the ability of the lakes to sustain such life.

DR. CHARLES WARDELL STILES, chief of the division of zoology of the Hygienic Laboratory, Washington, D. C., has been appointed delegate from the United States to the tenth International Zoological Congress, to be held in Budapest, Hungary, September 4 to 9. Dr. Stiles also will attend meetings of the International Committee on Zoological Nomenclature, which will convene in Budapest on August 28, and will be in session until September 4.

W. C. PARKINSON has left Peru to return to Washington after having completed the work he was engaged upon as consulting magnetician at the Huancayo Observatory.

PROFESSOR WARREN D. SMITH conducted the annual summer camp for geology of the University of Oregon in the Wallowa Mountains from June 15 to July 15, during which time he combined teaching with his personal research on some of the interesting problems of that region. In August he will be engaged as consulting geologist for the Reclamation Bureau on the Owyhee Irrigation Project Dam near Adrian, Ore., and still later in the summer will be occupied with special work in Lake County in connection with a suit concerning artesian water conditions.

THE topographical department of the Danish General Staff despatched a survey expedition to Greenland on May 25 of this year. It is under the command of Captain F. C. Jörgensen, and is based on Disko Island. The projected program of survey work will probably take thirty years to carry out. In addition, the expedition will supervise the construction of seismographic and wireless stations at Scoresby Sound.

DR. W. M. JARDINE, secretary of agriculture, gave the principal address on August 1, before the East Lansing meeting of the Country Life Conference.

SIR JOHN BLAND-SUTTON will present, on behalf of the Royal College of Physicians, London, an address of congratulation to the University of Toronto at the commemoration, on October 6, of the centenary of the granting of the charter of King's College, Toronto, now the University of Toronto.

SIR JOHN MACPHERSON, professor of psychiatry in the University of Sydney, New South Wales, has been nominated for Maudsley lecturer for 1928.

WHILE returning from work in the field in the vicinity of Salem, Ky., on the geology of the Smithland Quadrangle, Dr. Stuart Weller, professor of paleontologic geology for many years at the University of Chicago and assistant geologist on the Kentucky Geological Survey since 1920, died suddenly on August 5 in the automobile of a friend. Dr. Weller was fifty-seven years old.

A BRONZE plaque commemorating the life and work of Jacques Loeb, to be placed in the entrance of the auditorium, next to the tablet erected to Dr. C. O. Whitman, the founder of the laboratory, was unveiled at Woods Hole on August 4. Ten-minute addresses were made by Dr. Frank R. Lillie, president of the board of trustees and until 1926 director of the laboratory; by Dr. Simon Flexner, director of the Rockefeller Institute, of which Dr. Loeb was a member at the time of his death, and by Dr. Hardolph Wasteneys, of the University of Toronto, who was one of Dr. Loeb's students.

THE Society of Sciences, Letters and Arts of l'Aveyron has erected a monument in memory of the botanist, Hippolyte Coste.

Popular Astronomy, quoting from *Ciel et Terre,* reports that on the occasion of the distribution of prizes to the students in the Seminary and College of St. Catherine, where Donati received his education up to the time of his entrance to the university, the life of this noted astronomer was commemorated. The authorities of the city, Cardinal Maffi and a number of distinguished citizens assisted in the ceremonies. On December 16, through the aid of a committee of citizens of Pisa, a bronze tablet was placed on the house where Donati was born, and on the same day the one hundredth anniversary of his birth was celebrated. On this occasion Professor Marco Salvadori, of the College of St. Catherine, reviewed his life.

EDWARD S. HARKNESS has given the sum of $250,000 to Memorial Hospital, New York City, for the purchase of four grams of radium, doubling the supply now possessed by the hospital.

AN International Congress of Neurologists and Alienists opened on July 26, under the patronage of President Doumergue, at the Château of Blois, Paris, Professor Raviart, of Lille, presiding. The congress, which will last for five days, is being attended by four hundred delegates from seventeen countries.

THE combined meeting of the Section of Neurology of the Royal Society of Medicine and the American Neurological Association was opened on July 25 by a reception at the Royal Society of Medicine; guests were received by Sir James Berry, president of the society, and Lady Berry. Sir James Purves-Stewart, president of the section, gave an address on "Mount

Athos, a Survival of the Middle Ages." The Hughlings Jackson lecture was delivered by Dr. Charles L. Dana. During the afternoon demonstrations on pathological subjects were given, followed by a dinner in the evening.

A TOUR of delegates to the third World's Poultry Congress has been arranged so that European and other delegates may visit some of the more important educational marketing and poultry raising sections of the eastern United States. The party left Ottawa on August 4 and after visiting a few places in Canada proceeded to Cornell University, Ithaca, N. Y. Later the poultry and egg markets of New York City will be visited and the delegates will proceed through New Jersey to inspect the more important poultry raising sections of that state. Finally a visit will be made to the United States Department of Agriculture, where the visitors will be made acquainted with the work carried on by the Bureau of Animal Industry and the Bureau of Agricultural Economics.

THE International Conference on Flour and Bread Manufacture, postponed last year on account of technical difficulties, will definitely take place in Prague, Czechoslovakia, in September, 1927, under the auspices of the Czechoslovakian government. The exact date and full details of the program are yet to be determined. The preparatory committee has the following officers: *Chairman,* Jan Jolinek; *Editor,* Francis Hruska; *Secretary,* Karel Krtinsky.

A STATE clearing house of information on problems of delinquency and juvenile criminology was planned at a recent meeting of ten leading Wisconsin social workers sponsored by the Wisconsin Conference of Social Work. A plan for holding child guidance clinics in some 30 Wisconsin communities was also approved. Professor Kimball Young and Professor Robert West, of the University of Wisconsin, and Dr. R. E. Bushong, director of the Milwaukee County Mental Hygiene Clinic, were appointed to map out the work to be done by these clinics.

THE first National Fuels Meeting sponsored by the American Society of Mechanical Engineers will be held at St. Louis, from October 11 to 13.

Industrial and Engineering Chemistry reports that at the annual dinner of the American Welding Society held in New York City recently, President F. M. Farmer announced the donation of an award, the gift of Samuel Wylie Miller, to be presented by the society annually in appreciation of work of outstanding merit in advancing the art and science of welding. The award is a gold medal, which will be known as the Miller Medal.

R. H. FINCH, of the Lassen Volcanic Observatory, informs us that a museum to make better known the natural history of Lassen National Park was opened with a formal dedication ceremony on July 4. It is situated on the shore of Manzanita Lake near the northwestern entrance of the park. The museum was erected by Mr. and Mrs. B. F. Loomis as a memorial to their daughter Mae and they plan to turn it over to the National Park Service as soon as the boundary of the Lassen National Park is extended to include the area in which the museum is located. A pictorial history of the recent activity of Lassen Peak is the most striking part of the exhibit, though the wild life and the different kinds of lavas in the park are well displayed.

WE learn from the *Journal* of the American Medical Association that for two years about fifty members of the faculty of the University of California and assistants have been investigating the cause of pyorrhea. The Carnegie Corporation and various dental societies furnished about $100,000 to carry on this work. Some of the experiments seem to show that in animals and man a condition approximating pyorrhea can be induced by "slight upsets in the acid-base balance of their diet." On account of this seeming "tangential direction" which the research took, the stomatologic research committee of the university requested the Carnegie Corporation to send the following men to California for consultation on this problem: Dr. Lafayette P. Mendel, Sterling professor of physiologic chemistry, Yale University; Dr. Elmer V. McCollum, professor of biochemistry, the Johns Hopkins University School of Hygiene and Public Health, and Dr. Edward H. Hatton, professor of pathology and special research investigator, Northwestern University Medical School, Chicago. Dr. Mendel first made the trip, and Dr. McCollum went late in July. Dr. Hatton was expected to arrive early in August. Heretofore, research into the cause of pyorrhea has been largely through the approach of bacteriology rather than of nutrition.

THE departments of the University of Georgia Medical Department, Augusta, that were affected by the recent school fire are being renovated; the roof, the only part that burned, is being restored. The damage was estimated at $16,000. Space in the south wing, heretofore unused, is being converted into quarters for the department of experimental surgery with a large operating room, three rooms for research and an office. The space formerly used by the surgical department on the first floor will be taken over by the department of public health. The medical department is appealing to the legislature now in session for an increased appropriation of $20,000 a year for maintenance to replace a similar amount that

has been received for the last five years from the Carnegie and Rockefeller foundations, which contract has expired. The public-spirited citizens of the community and "official Augusta" contributed a similar amount to that given by the foundations, and these funds were used chiefly to inaugurate full-time departments in medicine, surgery and obstetrics.

UNIVERSITY AND EDUCATIONAL NOTES

A GIFT to the Yale library of $100,000 in memory of Albert DeSilver, '10, has been announced. The fund has been given to carry out the wish which Mrs. John Bradley Lord, of Greenwich, Conn., expressed shortly before her death in February, 1926, that a fund be established at Yale in memory of her son, Albert DeSilver. The income is to be used for the purchase and care of books and periodicals in the field of chemistry.

AN anonymous gift of £10,000 has been received by the University of Wales for the encouragement of research.

DR. A. WARREN STEARNS has been appointed dean of the medical school of Tufts College. He succeeds Dr. Stephen Rushmore, who has resigned to enter private practice.

DR. PAUL WHITELY, of the University of Chicago, has been appointed associate professor of psychology at Colgate University. Dr. Donald A. Laird, director of the laboratory of psychology, has been promoted to be professor of psychology and chairman of the department.

DR. EARLE B. MILLER, of the University of Wisconsin, has been appointed professor of mathematics and physics at Illinois College, Jacksonville.

DR. E. H. KETTLE, professor of pathology and bacteriology in the Welsh National School of Medicine, has accepted a professorship of pathology in the University of London. Dr. Bronislaw Malinowski, reader in the university, has been appointed to the university chair of anthropology, and Dr. W. H. Linnell has been appointed to a readership in pharmaceutical chemistry.

DISCUSSION AND CORRESPONDENCE

A NEW AGRICULTURAL PROFESSION

ABOUT twenty years ago the consulting agriculturist giving advice to farm owners for a consideration was almost unknown in the United States, although at that time Mr. George T. Powell, the well-known fruit grower, was one of the first pioneers in this profession. Then came various other "agricultural experts," "farm advisers," "consulting agriculturists" and "farm doctors," as they styled themselves—all more or less (principally less) competent—and most of them not staying in business very long. Soon after began the development of extension work and the county agricultural agent system paid for by federal, state and local funds. This system not only has been of great service to American agriculture but has had the effect of stimulating the farmer's desire for more information and advice especially adapted to his own particular farm conditions.

Overwhelmed as extension workers and county agents have been with constantly increasing demands for special service, it has been well-nigh impossible for them to devote any large proportion of their time to any one individual or company without offending other farm owners who felt that they were entitled to an equal amount of service. Yet it is evident that, if a farmer needs technical assistance, he must not only be given preliminary plans but also be assisted to work them out to a successful conclusion in full detail. Only one who has actually done it realizes the amount of time and work entailed in preparing a complete farm operating plan, including rotations, seed, fertilizer and spraying schedules, production and cost estimates and an operating budget. But when it comes to taking over the management of one or more farms only the professional agricultural consultant is free to devote himself to such work.

In following the development of the profession of consulting agricultural engineer, it is interesting to note the trend of state and federal agricultural agencies toward "service at cost." Thus county agent work itself has been partially supported by fees paid by the farmers themselves. Extension specialists making special inspections for farmers now have their traveling expenses paid by those whom they serve. An increasing number of agricultural bulletins is being sold instead of distributed free. Cow-testing associations formed by the agricultural colleges employ their own testers. And more recently in Illinois a group of farmers organized by the Agricultural College has hired its own salaried farm cost accountant to keep its members' books. So it is natural that the federal and state extension divisions should see in the consulting agricultural engineer a means of augmenting their own efforts with a saving of their time and appropriations. Where calls for special service are received some of these government agencies are now referring such inquiries to competent agricultural consultants. And as the demand for such professional services increases, it is believed that the agricultural colleges will help to meet it by offering special courses to train men for the profession of consulting agricultural engineer.

That this profession has at last received official recognition is evidenced by the recent action of the council of the American Society of Agricultural Engineers. Authority has been granted for the formation of a division of consulting agricultural engineers, with membership requirements for the admission of men of high professional standing and a code of ethics. This group of consulting agricultural engineers proposes to cooperate with federal and state agricultural agencies and its members are devoting themselves particularly to commercial agriculture.

STANLEY F. MORSE

NEW YORK, N. Y.

A PROBABLE ORIGIN OF PETROLEUM

THE article in your issue of July 1 in regard to tests being made by Dr. Parker D. Trask on sea-bottom muds for the presence of oils is of interest to me, as I have for many years believed that oil shales and mineral oils were the result of deposition formed, not on the sea-bottoms, but on the bottoms and shallows of brine lakes. My reasons for this belief are as follows:

Oil fields are quite frequently found contiguous to salt deposits, and the water which succeeds the oil in most wells is salt water.

In some brine lakes, such as Great Salt Lake, Utah, there is a great deal of marine life, but of very small size. In Great Salt Lake there is an abundance of very small shrimp or crayfish, and in certain of the marshes on the lake shores these small creatures seem to die in large numbers, so much so that the marshes in places give off an almost unbearable odor, much similar to the smell of drying cod fish.

The natural presumption is that the bodies of these small creatures do not decompose in the ordinary way but become pickled in the brine and are more or less permanently preserved.

Where conditions have been favorable and a mud bed formed, having the preserved remains of this small marine life imbedded in them, this mud might very readily have been changed into beds of shale carrying a large percentage of oil. Petroleum may possibly be a distillation from such shale, and being fluid may have moved about over a considerable area.

Mud banks would normally form at the mouths of rivers flowing into the brine lakes and the rivers would be continuously carrying into the lakes large quantities of organic matter, which would be acted on by the brine and deposited with the mud.

Some forms of vegetable life seem to grow freely in water containing a very high percentage of salt. Such vegetable matter probably would not decompose in the ordinary way. It seems quite possible that the difference in the composition of mineral oils from different locations may be due to the different proportions of animal to vegetable matter in the original deposition.

I have not the slightest doubt but that if Dr. Trask will test some of the muds near Salt Lake City he will find them to be rich in oil. These marshes are of considerable extent in places, and the mud might prove to be a source of oil of some commercial importance.

While brine lakes are not very numerous at the present time, in earlier geological periods they seem to have been quite numerous, and in some cases of vast extent, as is clearly indicated by the very extensive salt deposits to be found in many parts of the world.

JOHN ROGER

QUOTATIONS

THE SURVIVAL OF THE FITTEST

IN the struggle for existence that life represents, the survival of the fittest appeals to many thinkers as the outstanding ideal. They argue that it makes for strength and progress in the race if the unfit—the weaklings and the degenerates—are eliminated through their inability to meet the strenuous conditions of rigorous living. Consequently not a few persons challenge many features of the modern program for public health and preventive medicine as well as allied social schemes for human comfort on the ground that these tend to counteract and discount the advantages that selection through inherent fitness is alleged to represent. As a recent writer has expressed it, by protecting us from our enemies, the bacteria and the viruses; by removing the sources of disease; by showing us how to avoid unfavorable conditions and to find favorable ones; in short, by bringing us and our environment into harmony, the "civilizers" are promoting the survival of the unfit; they are progressively filling the human race with the weak and the degenerate, who must hand on their weakness and degeneracy to their descendants.

Such arguments can not be lightly dismissed. The modern investigations in genetics have, indeed, shown that it is quite possible to produce a population composed of the congenitally defective—"the halt, the blind, the weak, the variously deformed and degenerate." The biologist of to-day refers these possibilities back to the transmission of defective "genes," the hereditary substance carriers that determine development. In a stimulating address before the National Tuberculosis Association at Indianapolis in May, Professor Jennings,[1] of the Johns Hopkins University

[1] Jennings, H. S.: "Public Health Progress and Race Progress. Are They Incompatible?" SCIENCE 66: 4 (July 15) 1927.

sustained the thesis that defects in genes become as open to remedy as defects in nutrition. After all, the underlying problem is largely one of chemistry. The genes are chemical compounds. The consequences of a defective thyroid secretion are remedied by introducing synthetically produced thyroxin with the food. In principle it is clear, says Jennings, that defects in the store of chemicals given us by heredity may be supplied by other means; that undesirable things in the store of genes may be cancelled or corrected; that reactions among them which take an undesirable turn may be altered, set right. All these things, he adds, are seen to be mere matters of technic: one needs but to know how.

Of course, the correction of defects attributable to hereditary weaknesses does not necessarily abolish the latter. However thoroughly the natural effects of his "poor constitution" may be offset and his own life made more satisfactory alike to himself and to society, the defective individual continues to be a potential producer of the unfit. Shall he therefore be prevented from surviving? Not infrequently physical shortcomings go hand in hand with conspicuous mental capacities. The artist is by no means always an athlete. Shall the progress of the race be safeguarded by preventing the application of scientific ingenuity whereby the hereditarily weak may secure the enjoyment of a full, useful, happy, long life? To such queries Jennings has offered a cogent reply. The mere survival of a genetically defective individual does nothing to increase the degeneracy of later generations—provided he does not propagate. Not survival alone, but also propagation, Jennings rightly adds, is required for the perpetuation of defective genes. Without propagation, survival is harmless, so far as race deterioration is concerned.

The implications of these statements are fairly obvious. In their relation to the modern activities in the field of public health and social betterment they place burdens of responsibility where they have been only lightly considered heretofore. The public health worker, Jennings remarks, must become genetically minded, eugenically minded. If by his activities he promotes, in the congenitally defective, propagation as well as survival, his work does indeed tend toward a measure of racial degeneration. The control of the instincts that lead to propagation is a formidable problem. The subject is one that can not be thrust aside merely because it calls for considerable delicacy in presentation and, as yet, undevised tact in its furtherance. In any event the control of our environments will not be summarily abandoned. We still know too little about the details of heredity to assume that protective and defensive actions or selective control of the environment are inevitably threatening to human welfare in the long run. We may properly watch for defective genes and stop the propagation of their bearers; but, as Jennings concludes, the proposal to abandon control of the environment—the cessation of the process of adjusting ourselves to the conditions—is not a serious contribution to the practice of life. —*The Journal of the American Medical Association.*

SCIENTIFIC BOOKS

Catalogue of the Birds of the Americas and the Adjacent Islands in Field Museum of Natural History. Part V. Tyrannidae. By CHARLES E. HELLMAYR. Field Museum, Chicago, April 11, 1927. Pp. 517.

THE admirable synonymic and bibliographic catalogue of birds of the Western Hemisphere should be known to all zoologists. Begun years ago by Charles B. Cory, and continued after his death by C. E. Hellmayr, it stands as a model worthy of imitation by others than ornithologists. What a splendid thing it would be if in the course of time the whole fauna and flora of the Americas could be catalogued in this fashion! It is of course true that in many groups the genera and species are still so imperfectly known that no reasonably complete presentation of the fauna is possible. Yet there are other organisms than birds which could very well be listed in such a manner as to illustrate principles of geographical distribution, and give us a fairly adequate idea of the leading facts. Such, for instance, are the butterflies. Looking through the bird volumes, noticing the distribution of the species and subspecies, one is continually reminded of parallel facts in relation to the butterflies. If these latter could be listed in a similar fashion, and the two series compared, it is certain that interesting biological generalizations would emerge. A list of the terrestrial molluscs would be no less instructive. The method of the catalogue is to give the full synonymy and bibliography of each genus, species and subspecies, citing type localities, and giving the range as exactly as possible. In footnotes are added many critical comments, including brief diagnoses of subspecies, and often of genera.

To the general naturalist, special interest attaches to those birds which are peculiar to islands off the American coast. Several such are included among the Tyrannidae. The genus *Nesotriccus* (*N. ridgwayi* Townsend) is confined to the small Cocos Island, off the Gulf of Panama. It is however related to *Eribates* (*E. magnirostris* Gould), a genus only found in the Galapagos Islands. The scarlet or vermilion flycatchers (*Pyrocephalus*), well known on the mainland, are represented by two subspecies

in the Galapagos group, or five according to the former finer division of Ridgway (1894). One is peculiar to Chatham Island, while the other exists on nine islands. The isolated Juan Fernandez has a peculiar species (*Spizitornis fernandezianus* Philippi) of a continental genus. The Falkland Islands possess a *Muscisaxicola* (*M. macloviana* Garnot) which is only subspecifically distinct from the mainland representative; and the same sort of thing occurs in the Island of Fernando Noronha, off Brazil, the *Elaenia* (*E. ridleyana* Sharpe) obtained there being only a large insular race of a continental species. The genus *Elaenia* is rich in peculiar insular types in the West Indies, and has one on the Tres Marias Islands, off Mexico. *Myiarchus* is similarly rich in West Indian endemics, while the genus *Tolmarchus* is confined to the West Indies, with special forms in the Bahamas, Cuba, Cayman Islands, Jamaica, Porto Rico and Haiti. The monotypic genus *Hylonax* (*H. validus* Cabanis) is restricted to Jamaica.

T. D. A. COCKERELL

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE DEVICE USEFUL FOR DRAWING SYMMETRICAL OBJECTS

THE method commonly employed in drawing a bilaterally symmetrical object such as an insect is to make a drawing of one half of the object, either freehand or by use of a camera lucida, trace this on semi-transparent paper, and then retrace from the latter to outline the other half of the drawing. For several years I have used the device described below and have found it much more satisfactory than the tracing-paper method. Inquiry among entomologists, to whom it should be especially useful, has yet revealed no one familiar with it.

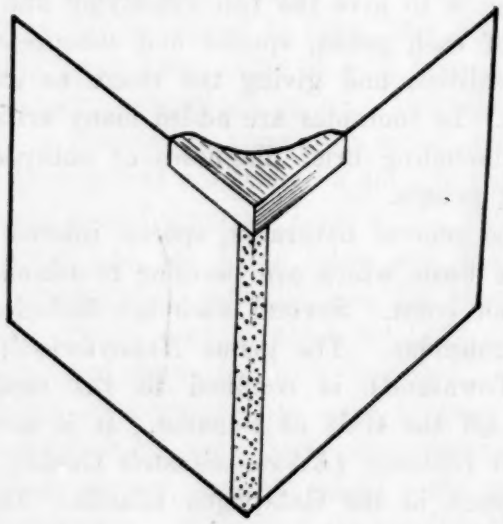


FIG. 1

The device consists essentially of two rectangular pieces of glass. A convenient form may be made by removing the emulsion from two 5″ x 7″ photographic plates and fastening these together in planes at right angles. They can be held rigidly in position by placing a narrow strip of adhesive plaster or binding tape along the angle where the edges meet and gluing across the upper corner a portion of the lid of a small pasteboard box, as shown in the accompanying figure.

Draw one half of the object and make a straight line constituting the median line of the final drawing. Then place one section of the glass upon this line, look diagonally through the glass from above the part drawn and outline the image on the opposite side.

RALPH H. SMITH

CITRUS EXPERIMENT STATION,
UNIVERSITY OF CALIFORNIA,
RIVERSIDE, CALIF.

AN AIR-TIGHT STOPPER FOR BOTTLES CONTAINING VOLATILE LIQUIDS OR FOR LARGE MARIOTTE APPARATUS

THE difficulties involved in securing air-tight seals with rubber stoppers are a matter of common experience to those working in the laboratory. This is particularly true where large Mariotte apparatus are employed or where volatile liquids are enclosed in bottles from which corks may be easily blown out. An expansible stopper is shown in the illustration which overcomes some of the uncertainties frequently accompanying the use of an ordinary stopper. The stopper was improvised for use on a metal Mariotte apparatus supplying a shallow evaporation tank. It was found to be so well adapted to the purpose that it has seemed desirable that some note should be made of it.

FIG. 1

As shown in the illustration the stem of a bolt with a large flat head is passed through a one-hole rubber stopper. A substantial washer is then placed over the stem of the bolt and above this a cylindrical metal sleeve which serves to carry the wing nut away from the mouth of the bottle affording greater freedom in tightening down on the rubber stopper. After such a stopper has been pushed into place, a few turns of the nut compress the rubber longitudinally and bring about a lateral expansion which holds the stopper in place and gives a sufficiently tight seal for any ordinary purpose.

FRANK M. EATON

BUREAU OF PLANT INDUSTRY

THE FINDING OF PLEISTOCENE MATERIAL IN AN ASPHALT PIT AT CARPINTERIA, CALIFORNIA

IN February, 1927, on the Lucien Higgins ranch in Carpinteria in southern Santa Barbara County, California, a steam-shovel which was taking out road material over a deposit of asphalt disclosed some bones. These were brought to the attention of Mr. Norton Stuart, curator of the Santa Barbara Museum of Natural History. Mr. Stuart at once began an investigation of the field and after several unsuccessful attempts to locate the source of the earlier finds, at last discovered a mass of material which extends to a depth that has not yet been measured. Here Mr. Stuart found a great number of bones of birds, mammals and rodents, together with pine cones, leaves and other plant material.

Mr. Stuart was able to identify some of the bones as those of *Teratornis*, others as those of a horse, close to *Equus occidentalis*, and the cones as those of the Monterey Pine, *Pinus radiata*.

The Santa Barbara Museum of Natural History then invited Mr. Chester Stock and Mr. Ralph Chaney to examine the material which had been discovered, and has arranged with the Carnegie Institution to continue the excavation and the study of the material disclosed.

The discovery of this interesting material exemplifies the value of a local natural history museum on whose staff are men who can grasp the significance of such local discoveries.

RALPH HOFFMANN,
Director

SANTA BARBARA MUSEUM
OF NATURAL HISTORY

PLEISTOCENE FAUNA AND FLORA

ALTHOUGH bituminous deposits along the coast of southern California, between Santa Barbara and Ventura, have been known for a number of years, the early mining operations for asphalt in this region apparently never brought to light the presence of fossil remains in these accumulations. Recently the discovery of vertebrate and plant materials of Pleistocene age in an asphalt bed south and east of Carpinteria, made as a result of excavations for road materials, has directed the attention of the Santa Barbara Museum of Natural History to this locality.

The deposit in which the fossil organisms are found has been described and referred to by several authors. It was considered in some detail by Eldridge[1] in his extensive report on the asphalt and bituminous rock deposits of the United States. In 1907 Arnold[2] showed the extent of this deposit on the geological map of the Summerland Oil District, Santa Barbara County, California, and discussed its occurrence in the report on the geology and oil resources of the Summerland region.

Through the kindness and cordiality of Mr. Ralph Hoffmann, director of the Santa Barbara Museum and Mr. Norton Stuart, curator, the Carnegie Institution of Washington and the California Institute of Technology have been invited to explore the locality and to cooperate with the Santa Barbara Museum.

The geological section is well exposed in the sea-cliff one half to three quarters of a mile southeast of Carpinteria and is essentially that described by Eldridge. The Pleistocene deposits containing the vertebrates and plants lie unconformably above highly inclined Tertiary (Miocene) shales and sandstones, resting upon a surface apparently developed as a result of marine planation of the older rocks. The Pleistocene formation is practically in horizontal position and reaches a thickness in cliff-section of 10 to 12 feet. It consists of sharp sand and some gravel and has been thoroughly impregnated by petroleum. The sand is sometimes cross-bedded. Eldridge records the finding of an occasional shell in this stratum.

Overlying the bituminous sand and gravel is a white or brownish sand which is at least two and one half feet thick and may be somewhat thicker. This sand has not been penetrated extensively by petroleum and, as compared with the underlying formation, may be regarded as practically free of such penetration. That the unimpregnated sand accumulated after a second period of erosion during which a part of the bituminous sand was removed and the bed containing the remains of land organisms

[1] Eldridge, G. H., 22nd Ann. Rpt. U. S. Geol. Surv., Pt. I, pp. 444–445, pl. 58, 1901.

[2] Arnold, Ralph, U. S. Geol. Surv. Bull., pp. 33–35, pls. 1 and 3, 1907.

was truncated is suggested by the relationships of the two deposits.

Above the white or brownish sand is a dark earthy material reaching a thickness of at least six feet. In the vicinity of the fossil occurrence the soil layer contains many marine shells and shell fragments and these are strewn also over the surface of the ground. Indian remains and implements have been found in the soil stratum, pointing quite unmistakably to the fact that the locality has been occupied in recent time as an Indian site.

The Pleistocene mammals, birds and plants found in the bituminous layer appear to be concentrated in a relatively small area, but further exploration may reveal a more extensive accumulation of remains. The occurrence is unique in that it has furnished a large representation of plant remains. The plant assemblage is discussed below by Dr. Ralph W. Chaney and Mr. Herbert L. Mason, and the birds by Dr. Loye Miller.

The mammals occurring at the Carpinteria locality include the following forms:

Aenocyon, near dirus Leidy
Canis, probably ochropus Esch.
Urocyon, near californicus Mearns
Mephitis, sp.
Odocoileus, sp.
Equus, near occidentalis Leidy
Lepus, sp.
Eutamias, sp.

The mammals include types found also at Rancho La Brea and at McKittrick. The single exception is the chipmunk which is not recorded at the Los Angeles locality and thus far has not been recognized at McKittrick. The assemblage contains certain elements suggestive of a forest environment, thus presenting the possibility of ecologic conditions which differ somewhat from those prevailing at Rancho La Brea and at McKittrick during the period of their accumulation. The time relationship of the Carpinteria fauna to those from the asphalt stations mentioned above may be more definitely stated when further collections are obtained.

An important feature of the occurrence is the apparent clearness with which the relationship of time of accumulation of the animal and plant remains to the geological record of this region can be established.

CHESTER STOCK
CALIFORNIA INSTITUTE OF TECHNOLOGY,
PASADENA, CALIF.

BIRD REMAINS

THE bird remains examined total eighty determinable specimens which are distributed on preliminary examination among fifteen species, all of which have been reported from Rancho La Brea and all but two of which are common to Rancho La Brea, McKittrick, and the new horizon under discussion.

Four of the species are extinct, namely *Teratornis, Parapavo, Neophrontops,* and *Neogyps.* A fifth species, *Polyborus,* is foreign to the region in Recent time. *Parapavo* and *Gymnogyps* do not occur at McKittrick. Thus the fauna shows closer affinity with Rancho La Brea than with McKittrick, suggesting that the San Diegan region was distinguishable from the San Joaquin Valley Region by faunal differences as it is to-day. Such a form as *Parapavo* might naturally be expected to conform to the physiographic barrier of the Lliebre and the Tejon Mts. even though less elevated than at present. That the strong flying *Gymnogyps* should have been so restricted is difficult to believe.

List of species and specimens of birds. The asterisk (*) indicates a species extinct in the region to-day.

	Specimens
Anas platyrhynchos (?)	2
**Parapavo californica*	17
Lophortyx californica	1
Gymnogyps californianus	4
**Teratornis merriami*	1
Aquila chrysaetos	28
Buteonid hawks	15
**Neogyps errans*	1
**Neophrontops americanus*	1
**Polyborus cheriway*	2
Bubo virginianus	2
Colaptes cafer	2
Geococcyx californianus	1
Corvus corax	2
Small passerine species	1
	80

The single species of swimmer and the total absence thus far of waders coupled with the occurrence of such species as the road runner and the California peacock would indicate a coastal plain quite independent of strand influence.

LOYE MILLER
UNIVERSITY OF CALIFORNIA,
LOS ANGELES, CALIF.

FOSSIL PLANTS

ANY facts that bear upon the subject of the origin and distribution of endemic floras are particularly welcome. This field of science has at its command very little in the way of evidence that is concrete or convincing. Therefore the finding in the geological record of fossil materials that prove the existence of a flora in past time in a locality remote from its

present distribution is most significant. Such is the recently discovered flora of the Pleistocene Brea deposits at Carpinteria, Santa Barbara County, California.

This flora as now known represents a forest assemblage dominated by coniferous trees with a heavy undergrowth of shrubs and herbs. Following is a list of fossil plants thus far found in the deposit:

Pinus radiata Don.
Pinus muricata D. Don.
Cupressus goveniana Gord.
Arceuthobium, sp.
Chorizanthe, sp.
Platanus, sp.
Amelanchier, sp.
Arctostaphylos, 3 species.
Numerous other small elements not yet identified.

Two hundred miles northward there exists to-day a relict flora limited to the coastal slopes in the vicinity of Monterey Bay. Small groves occur northward and southward over a total distance of about fifty miles. This forest flora is dominated by the Monterey Pine (*Pinus radiata* Don.) and has associated with it the Bishop Pine (*Pinus muricata* Don.), the Monterey Cypress (*Cupressus macrocarpa*), and the Gowen Cypress (*G. goveniana* Gord.). The ground cover of this forest is composed largely of shrubs of Manzanita (*Arctostaphylos*) and California lilac (*Ceanothus*), there being several species of each. Aside from these there are many other less common shrubs and a host of herbaceous plants. It is this forest flora that existed in Pleistocene time in the vicinity of Carpinteria, practically as it exists to-day on the slopes back of Monterey Bay.

The preservation of the fossil material is particularly fine and the completeness of the specimens is unique. The conifers are all represented by wood, leaves, ovulate and staminate strobile; the mistletoe is represented by twigs, scale-leaves, staminate and pistillate flowers, and fruits; the Manzanitas by wood, leaves, flowers and fruits. Particularly noteworthy are the flowers of Amelanchier and of the Manzanitas, in which minutest details as to pubescence, surface markings and stamen peculiarities are plainly discernible. Epidermal layers of leaves show remarkable structure of tissue and stomata. Sections of much of the wood show mycelial threads of parasitic fungi as well as the borings and remains of beetles. The threads of fungi, preserved and stained by petroleum, stand out in striking contrast to the tissues of the wood.

The absence of Ceanothus in the fossil deposits is noteworthy, as it occupies such an important position in the living forest. However, further excavation is expected to bring to light other species and it is reasonable to suppose that Ceanothus may be among them.

In comparing the flora with that of the other tar deposits of California it is significant to note that there is but one species in common with each of them. *Pinus muricata* is found also at Rancho La Brea and one species of Arctostaphylos occurs in the McKittrick deposit. The La Brea flora contains a Cypress specifically distinct from that at Carpinteria. It is associated with elements indicating a drier habitat such as *Juniperus* sp., *Quercus agrifolia* Nee, *Celtis* sp. and other elements of a similar nature. The La Brea flora appears to be ecologically comparable to the openly wooded hills of the inner California Coast Ranges, whereas the Carpinteria flora is obviously coastal. The McKittrick flora has not yet been studied but in all probability is of the inland type.

From the fact that all the fossil plants from Carpinteria are identical or similar to species now living in California it seems proper to refer this flora to the Pleistocene. The assemblage indicates a climatic change in the region since Pleistocene time involving a lessening of the rainfall, an increase in the evaporation rate, and a considerable lessening of the amount of summer fog.

RALPH W. CHANEY
CARNEGIE INSTITUTION OF WASHINGTON
HERBERT L. MASON
UNIVERSITY OF CALIFORNIA

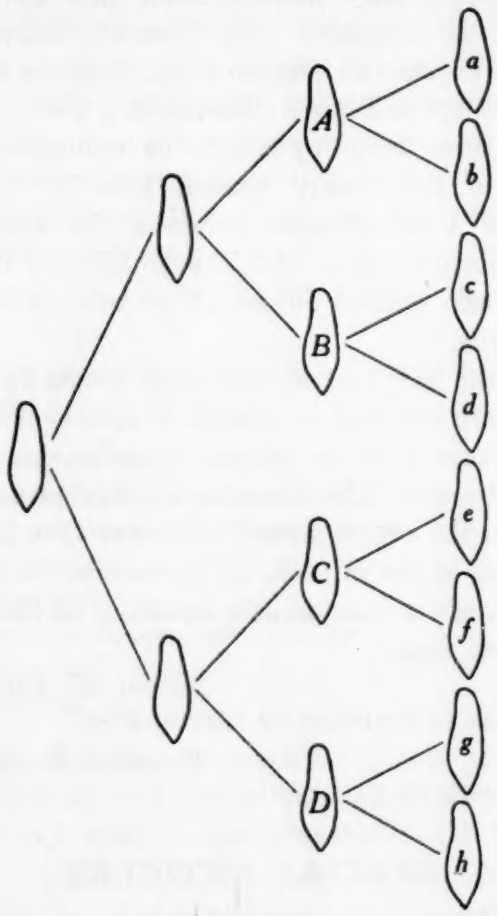
SPECIAL ARTICLES

THE AXIAL GRADIENT IN PARAMECIUM

IN work on the effect of crowding in *Paramecium caudatum* it was noticed that individuals from the same parent, under identical conditions, divided at different rates. Further, it was found that in the isolated fission products of animals which had divided in the morning the anterior piece had a more rapid rate, but in those isolated in the evening after division, the posterior piece divided first. This suggested a temperature effect. To test this the exact time of division of fission products was recorded for three filial generations at three temperature ranges; in fifteen cases at 26 to 30 degrees, in fourteen cases at 18 to 22 degrees, and in twelve cases at 13 to 17 degrees Centigrade. The experimental animals were transferred from room temperature, 18 to 22 degrees, to the high or low temperature for the period of the experiment. Constant attention was required in the experiments, for approximately forty-eight hours at highest temperature and over seventy-two hours at

low temperature, in the effort to obtain the exact time of division of all the progeny and to identify the fission products at the time of division and to reisolate them to the fourth generation.

In the division of the first filial generation at 26 to 30 degrees, the anterior cell always divided before the posterior; at 13 to 17 degrees, the posterior piec always divided first; and at 18 to 22 degrees the relative rate varied. The following table gives the distribution of cells having the highest and lowest rates at the high and low temperatures (see diagram).



Temperature		26–30°		13–17°
	Piece	per cent.	Piece	per cent.
	a	79.9	h	91.6
Highest rate.....	e	13.3	d	8.3
	c	6.7		
	h	93.3	c	41.6
	f	6.7	a	33.3
Lowest rate.....			e	16.7
			g	8.3

In the third generation at high temperatures, the "a" piece had the most rapid rate in 79.9 per cent. of the cases and in the other 20.1 per cent. it came second, while the "e" piece, which is the anterior piece of the posterior cell produced in the second generation, had the highest rate in 13.3 per cent. of the cases. The "h" piece under these conditions had the lowest rate in 93.3 per cent. and the "f" piece in 6.7 per cent. of the cases.

At the low temperature range, 13 to 17 degrees, there is a marked reversal. The "h" piece divided most rapidly in 91.6 per cent. of the cases and in all other cases the "d" cell had the most rapid division rate, but there was considerable variation with respect to which pieces showed the lowest rate; "a" pieces were lowest in 33.3 per cent.; "c", in 41.6 per cent., "e", in 16.7 per cent., and "g", in 8.33 per cent. Here there is indicated a possibility of acclimatization or recovery in the anterior pieces, since in the preceding division the "A" piece had the lowest rate in 74.9 per cent., and the "C" piece in 25.1 per cent.

At the intermediate temperature range, 18 to 22 degrees, there was no noticeable order of division.

These results suggest an interpretation in terms of Child's gradient theory. The axial gradient in Paramecium has been indicated by various methods, but the evidence from cell lineage presented here is of particular significance since there is less uniformity in cytolysis along the axis of Paramecium than with any other ciliate thus far examined.[1] It has been shown for some forms, *e. g.*, Planaria, that a rise in temperature up to a certain point accelerates the more active levels to a greater degree than the less active. In view of these facts it may be suggested that the sudden rise of temperature accelerates, and the lowering of temperature retards physiological activity to a greater extent in the anterior than in the posterior region of the body. Some of the data suggest that if the cultures were kept at the different temperatures for a longer time, acclimatization would obliterate the differences in division rate.

At the intermediate temperature the anterior end is neither inhibited nor accelerated sufficiently to show either a more or less rapid rate of division consistently. Apparently there may be an inheritance of the relative regional metabolic rates of the original animal in the fission products at least to the third filial generation.

The differential rate of division of progeny of a single individual may account for some of the difficulties involved in obtaining consistent results in experimental work on Paramecium.[2]

WALBURGA PETERSEN

WHITMAN LABORATORY
OF EXPERIMENTAL ZOOLOGY,
UNIVERSITY OF CHICAGO

[1] Child, C. M., and Deviney, Ezda, 1926. "Contributions to the Physiology of Paramecium caudatum." *Jour. Exp. Zool.*, Vol. 43, p. 257.

[2] I am indebted to Professor W. C. Allee, of the Department of Zoology, and to Dr. Marie A. Hinrichs, of the Department of Physiology, for suggestions during the progress of this work.